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Hurst

[11] **3,768,453**

[45] **Oct. 30, 1973**

[54] **EXHAUST EMISSION CONTROL FOR INTERNAL COMBUSTION ENGINES UTILIZING AN ELECTRICALLY HEATED CHOKE**

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[52] **U.S. Cl.** ..... **123/119 F,** 123/179 G, 261/39 R, 261/39 B, 261/39 E

[51] **Int. Cl.** .. **F02d 11/08,** F02m 1/10, F02m 23/04

[58] **Field of Search** ..... 123/119 F, 179 G; 261/39 E, 39 R, 39 B

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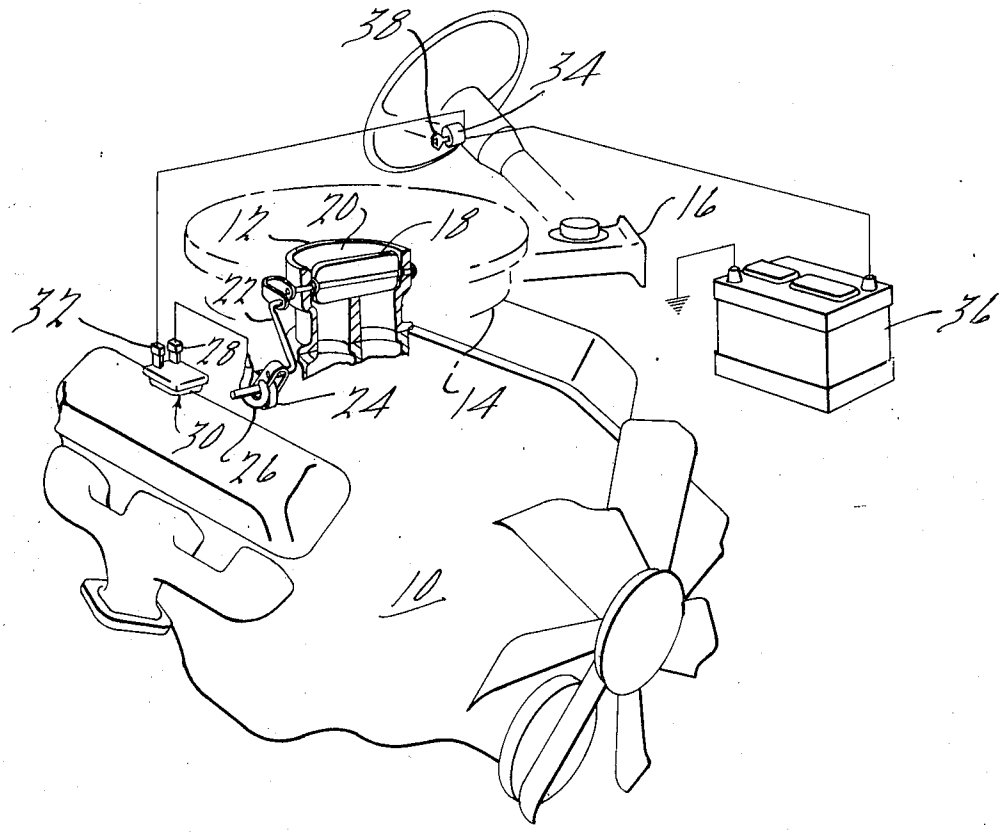
Primary Examiner—Wendell E. Burns

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[57] **ABSTRACT**

In a motor vehicle having an internal combustion engine including a carburetor for mixing fuel and air together prior to combustion in a cylinder, an electrically heated choke is provided to shorten the time period of choke operation at ambient temperatures greater than 68°F. A pair of thermostatic control switches control the operation of a choke heater adjacent to the choke during engine starting and warm-up, thereby reducing hydrocarbon and carbon monoxide emissions.

13 Claims, 6 Drawing Figures



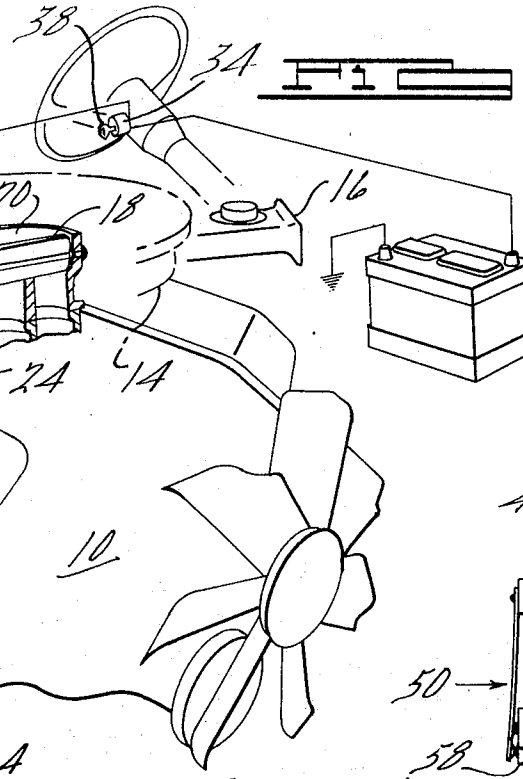


Fig. 1.

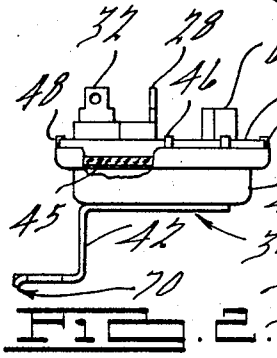


Fig. 2.

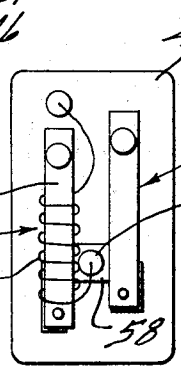


Fig. 3.

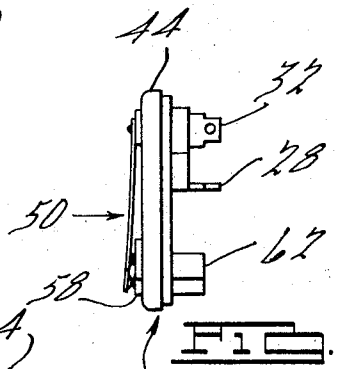


Fig. 4.

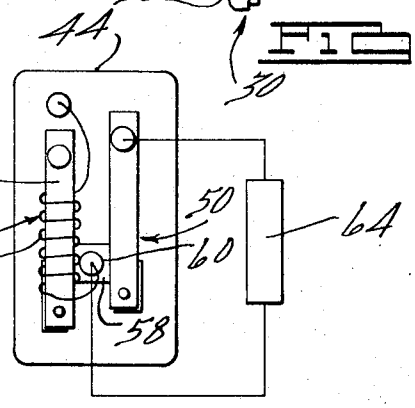


Fig. 5.

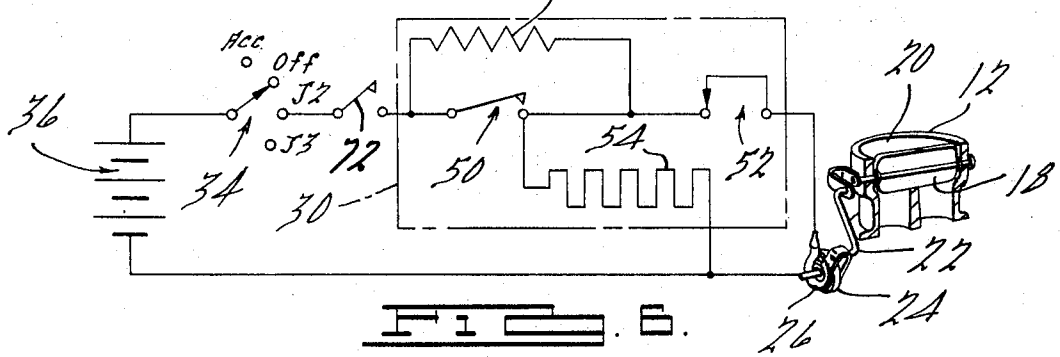


Fig. 6.

EXHAUST EMISSION CONTROL FOR INTERNAL COMBUSTION ENGINES UTILIZING AN ELECTRICALLY HEATED CHOKE

BACKGROUND OF INVENTION

1. FIELD OF INVENTION

This invention relates to emission control systems in general, and in particular to thermal control of automatic chokes in internal combustion engines.

2. PRIOR ART

Automatic chokes in internal combustion engines are typically responsive to certain engine temperatures for their operation. Several systems, such as U.S. Pat. No. 2,969,785, utilize solenoids responsive to thermal active switches for operation of the choke valve in the carburetor. Such thermal active switches are generally responsive to engine temperatures for controlling the amount of current supplied to a solenoid, thereby controlling the degree of opening of the choke valve. Some systmes use a plurality of switches which are responsive to different engine temperatures for opening the choke valve by a series of discrete steps.

Other systems teach the utilization of air withdrawn from the air cleaner, passed through a heater and applied to the choke control. The heater is controlled by a thermostatic switch which is responsive to the manifold gas temperature. Other systems provide a heater positioned adjacent to the choke control system which is controlled by the operator of the motor vehicle. In these systems the heater is continuously connected to a source of power and is not responsive to any temperature sensing element.

SUMMARY OF THE INVENTION

It is a principal object of this invention to provide a system for an internal combustion engine to reduce the hydrocarbon and carbon monoxide emissions due to choke enrichment of the fuel air mixture.

It is another object of this invention to shorten the period of choke operation when the ambient temperature is above a predetermined level.

These and other objects which will become apparent from the following detailed description and drawings relating to an internal combustion engine having a fuel system comprising a carburetor for mixing the fuel and air prior to the entry of the mixture into the cylinder. The carburetor is further controlled by the choke valve positioned within the air intake tube which is responsive to a thermal bimetal member controlling the amount of air flowing into the carburetor from the air filter. An improvement in the choke control system comprises a first normally open switch such as an ignition switch for controlling the flow of current from the battery. Electrically connected in series with the first switch is a second normally open thermostatic switch that is responsive to a predetermined ambient temperature in the environment of the internal combustion engine. A third normally closed electrothermal switch is electrically connected in series with the first two switches and is responsive to a delay element for actuation a predetermined time after power is applied to the delay element. A heating element is electrically connected in series between said third switch and the return side of the battery and is mechanically positioned in a thermal relationship with the thermal bimetal member of the choke. The heating element supplies heat to the bimetal member for a predetermined period of time controlled by the third switch to actuate the choke to an open position thereby reducing the choke enrichment of the fuel air mixture being supplied to the cylinder.

DESCRIPTION OF DRAWINGS

In the drawings:

FIG. 1 is a perspective view partly in section of an internal combustion engine within the environment of a motor vehicle;

FIG. 2 is an elevation view partly in section of the electrothermal control unit including a mounting support;

FIG. 3 is a plan view of the electrothermal control unit with the covers removed;

FIG. 4 is a side view of the electrothermal control unit of FIG. 3;

FIG. 5 is a modification of the electrothermal control unit of FIG. 3; and

FIG. 6 is an electromechanical schematic illustration of the electric assist choke.

DETAILED DESCRIPTION

Referring to the figures by characters of reference, there is illustrated in FIG. 1 an internal combustion engine **10**, such as may be found in a motor vehicle. Positioned on the top of the engine **10** is a carburetor **12** which is covered by an air cleaner unit **14** having an air intake means **16**. The carburetor **12** is diagrammatically illustrated in section showing the position of the choke or butterfly valve **18** in the air intake passage **20** of the carburetor. The butterfly control valve **18** is connected by the linkage **22** to a thermal bimetal member **24** that is heat responsive for opening the butterfly valve **18** in the position illustrated in FIG. **1**.

Positioned in thermal coupling relationship with the bimetal member **24** is a heater member or calrod **26**. The heater member **26** is electrically connected between ground and a first input **28** of an electrothermal control unit **30**. The second input **32** to the thermal control unit **30** is electrically connected to the J2 position of the ignition switch **34**. The input to the ignition switch **34** is electrically connected to the vehicle battery **36** in a conventional manner. Thus it is seen when the ignition switch is actuated by a key **38**, power is supplied from the battery **36** through the thermal control **30** to the heater **26** in the choke well of the internal combustion engine **10**.

Referring to FIG. **2**, there is illustrated a plan view of the preferred embodiment of the three terminal, temperature sensitive, electrothermal control unit **30**. The control unit **30** comprises a metallic housing **40** including a mounting bracket **42**, a glass-filled alkyd or an electrically non-conductive base plate **44** and a gasket or sealing member **45**. The base plate **44** is secured to the housing **40** by means of several tab members **46** positioned about the periphery of an opening along one side of the housing. One tab member illustrated as **48** functions to provide the electrical ground connection between the housing **40** and the electrical contact assembly mounted on the base **44**.

FIG. **3** illustrates a plan view of the thermostatic switches contained within the housing **40** and mounted on the base **44**. The switch assembly comprises a pair of thermal activated switches **50** and **52** and a heater coil **54** wound around one blade **56** of the electrothermal switch **52**. The first thermal switch **50** is a normally

open switch which is activated to a closed position at a predetermined temperature. In the preferred embodiment, this temperature is the ambient temperature found in the environment of the internal combustion engine **10** and the switch is adjusted to close at a temperature exceeding 68°F. and to open at a temperature below 48°F. The second switch **52** is a normally closed switch and is actuated in response to the heat generated by the passage of current through the heater **54.** As illustrated in FIG. **3,** the heater coil **54** is wound around one switch blade **56** of the switch **52.** The switch contact **58** which is common to each of the switches **50** and **52** is an elongated member secured to the mounting base by means of a rivet **60.** This contact member is individually adjusted for each of the thermal switches **50** and **52;** such adjustment controlling the temperature operation of the switch. The adjustment is made by an adjusting screw mounted in each one of a pair of turrets **62** extending away from the mounting base. The first thermal actuated switch **50** as previously indicated is adjusted to sense ambient temperature above 68°F. When the ambient temperature is greater than 68°F., the switch is closed and will remain closed until the ambient temperature drops below 48°F. The second thermal actuated switch **52** is responsive to the heat generated by the heater element **54** which is electrically connected in series across the battery **36.** The current drain of the winding of the heater element **54** is less than 100 milliamps and the heat generated by the coil will cause the switch to actuate from a normally closed to an open position in a time period of approximately four minutes.

FIG. **5** illustrates a modification of the exhaust emission control system with the addition of a resistor element **64** electrically connected in parallel with the ambient temperature switch **50.** As will hereinafter be shown, the purpose of this resistor is to eliminate the exhaust manifold heat riser valve which controls the flow of the exhaust gas taken from the manifold and applied to the choke well.

Referring to FIG. **6,** there is illustrated in an electromechanical schematic form, the operation of the exhaust emission control system including the modification of FIG. **5.** During engine starting or as typically referred to as "cold starting" or during the beginning of an engine warmup, the hydrocarbons or the carbon monoxide emissions from the exhaust system increase because of the choke enrichment of the fuel air mixture. In this particular condition, the choke or butterfly valve **18** is closed thereby blocking the air passage along the air intake passage **20** of the carburetor **12.** This places a rich fuel mixture in the cylinder during this period of time. Once the car is under way the choke is gradually opened by means of a thermal bimetal member which is responsive to the engine temperature as manifested by the exhaust manifold gas. As previously indicated, this gas is supplied to the bimetal member **24** by means of a manifold heat riser valve interconnecting the manifold passageways with the automatic choke well in the internal combustion engine **10.** When the ambient temperature is extremely warm, the engine need for such an enriched fuel air mixture is greatly reduced and if the choke were to remain closed for a period of time this would result in a loss in performance of the engine and higher hydrocarbon and carbon monoxide emissions. Therefore, in warm temperatures it is desired to have the choke or butterfly valve **18** open in a much shorter time than usual.

In order to open the choke in a shorter period of time, the thermal bimetal member **24** must be heated for actuation. The heater **26** which in the preferred embodiment is a circular shaped calrod heater, is positioned in thermal relationship to the bimetal member **24** such that heat generated by the heater is sensed by the member **24.** One side of the calrod member **26** is electrically connected to ground through the casing of member **26** and the other side is electrically connected over conductor **68** to the contact **56** of the thermal actuating switch **52.** As previously indicated, the switches **50** and **52** are electrically connected in series and to the run or J2 contact of the ignition switch **34.** Due to the construction of the ignition switch **34,** the run or J2 contact and the start or J3 contact are electrically connected together during engine starting. As indicated in FIG. **6,** the battery is electrically connected to the ignition switch **34** supplying power to the system. Electrically connected between the contact **58** and the return side of the battery **36,** is the heater winding **54.** Also as illustrated in FIG. **6,** is the modification of FIG. **5,** namely, the resistor element **64** which is electrically connected parallel with the thermal actuated ambient switch **50.** It is seen that the system is basically a single wire system with the electrical return being provided through the ground connection made by the housing mounting bracket **42** against the engine block. In order to provide a better ground, the end of bracket **42,** which is against the block, has a pair of down-turned sharp points **70** which attempt to embed in the block when the bracket is fastened to the block by means of a bolt means, not shown.

When the ambient temperature is greater than 68°F., the ambient switch **50** is closed. When the vehicle operator attempts to start his car by turning the key **38** in the ignition switch **34,** electric poser is supplied from the battery through the closed contacts of the switch **50,** the normally closed switch **52** to the calrod unit **36** to apply heat to the bimetal member **24.** Additionally, the heater winding **54** is placed in series with the battery **36** through the switch **50** and the ignition switch **34.** After a predetermined period of time, which in the preferred embodiment is approximately 4 minutes, the heating element **54** generates sufficient heat to cause the thermal actuated switch **52** to open thereby removing power from the calrod unit. In this period of time sufficient heat has been transferred to the bimetal member **24** causing the choke **18** to open increasing the amount of air to the fuel air mixture. As long as the vehicle is in the run position, current is continuously flowing through the heater winding **54** maintaining the switch **52** in an open condition.

When the ambient temperature is less than 48°F., the thermal actuated switch **50** is opened and current flows from the battery **36** through the resistor **64** to the switch contact **58.** During cold start a reduced amount of current is flowing to the calrod unit **26** due to the value of the resistor **64.** With this reduction of current, the amount of heat generated by the calrod unit **26** is reduced. It is in this operation that the function of the resistor **64** duplicates the function of the exhaust manifold heat riser valve. After a predetermined period of time, the thermal actuated switch **52** opens removing the electric power from the calrod unit **26.** The choke at that time is then responsive to engine temperatures

radiating from the engine block and the butterfly valve **18** will open in response to the engine temperature.

As previously stated, the electrothermal control unit **30** is a three terminal or two terminal with grounded housing, temperature sensitive, electrothermal device. The first terminal corresponds to the first input **28** and is electrically connected to the heater **26.** The second terminal corresponds to the second input **32,** and is electrically connected to a source of power through the ignition switch **34** and the third terminal is the ground terminal provided by the mounting bracket **42** including the sharp points **70** thereon. The mounting base **44** is a non-conductive base plate which, as previously indicated, is fabricated from glass-filled alkyd material because of its rigid stability at the high temperatures found in an engine compartmemt. Due to the nature of bimetallic switches, the base **44** must remain undistorted in order for the switches **50** and **52** to function. Also, the material selected must, of necessity, be corrosion resistant so as not to adversely affect the electrical circuit. The base **44** is supported in the housing **40** by a gasket material **45** to assist in sealing the switches from any corrosive particles such as water, dirt, etc., which would cause the switches to malfunction.

The control unit **30** is typically mounted on the engine near the choke. This allows the unit to be responsive to the ambient temperature in the area of the choke. Other mountings, such as on the fire wall of the engine compartment, may result in incorrect operation due to the sensing of temperature which is not the same as that found in the choke area.

An additional modification to the system of FIG. **6** is the further control of the voltage being applied to the control unit. This further control delays the application of the voltage until the engine is actually started. This may be accomplished by using a switch **72** which is engine-operation responsive and is electrically placed in series with the ignition switch **34** before the control unit **30.** An example of such a switch is a vacuum switch. In this manner, the heater would not be energized until the engine was in operation.

By reducing the percentage of fuel in the fuel air mixture, combustion is more complete and the hydrocarbon and carbon monoxide emissions are decreased. Such emissions are functions of the cylinder temperature and the makeup of the fuel air mixture into the cylinder.

There has thus been shown and described, an improved exhaust emission control system for controlling the carbon monoxide and hydrocarbon emissions from an internal combustion engine during cold start and warm-up times. In response to thermal actuated switches within the system once the internal combustion engine has sufficiently warmed up for a period of time, the carburetor acts under control of the engine temperature.

What is claimed is:

1. In an internal combustion engine having a fuel system comprising a carburetor for mixing fuel and air prior to the entry of the mixture into a cylinder, and a choke valve positioned within the air intake passage of the carburetor, said valve responsive to a thermal bimetal member for controlling the amount of air into the carburetor, an improved exhaust emission control comprising:

a first normally open switch electrically connected to one side of a source of power;

a second normally open thermostatic switch electrically connected in series circuit with said first switch and responsive to a predetermined temperature for actuation;

a third normally closed thermostatic time delay switch electrically connected in series circuit with said second switch, said third switch responsive to a predetermined temperature for a predetermined period of time for actuation, and

a heating element electrically connected in series circuit between said third switch and the other side of the source of power, said heating element positioned in thermal relationship to the thermal bimetal member for supplying heat thereto for a predetermined period of time controlled by said third switch when said first and second switches are actuated.

2. In the improved exhaust emission control according to claim **1** wherein said third switch comprises an electrically responsive heater winding electrically connected between the junction of said first and second switches and the other side of the source of power for generating a quantum of heat, and

a thermal responsive bimetallic normally closed switch member, said switch member responsive to the quantum of heat after a predetermined period of time for actuation.

3. In the improved exhaust emission control according to claim **1** wherein said second thermostatic switch is responsive to temperatures exceeding 68°F. for actuation thereof.

4. In the improved exhaust emission control according to claim **1** additionally including a resistor electrically connected in parallel circuit with said second thermostatic switch for supplying reduced electrical power to said heating element when said second switch is open and said first and third switches are closed.

5. In the improved exhaust emission control according to claim **1** additionally including an engine-operation responsive switch in electrical series with said second and third thermostatic switches for controlling the application of electric power to said heating element until the engine is in operation.

6. In an internal combustion engine having a carburetor for mixing fuel and air prior to the entry of the mixture into a cylinder, and a choke valve positioned within the air intake tube of the carburetor for controlling the amount of air into the carburetor, said valve responsive to a thermal responsive actuating member, an exhaust emission control system comprising:

an electrothermal control device having;

a thermal responsive switch normally open and actuated to a closed position at a predetermined temperature; and

a thermal responsive time delay switch normally in a closed position and responsive to a predetermined temperature for actuation to an open position, said first mentioned switch and said time delay switch electrically connected in a series to a source of electrical power; and

a heater member positioned in a thermal coupling relationship with the thermal responsive actuating member controlling the choke valve, said heater responsive to the flow of current through said electrothermal control device for radiating thermal energy for actuating the choke valve to increase the flow of air into the carburetor after a predeter-

mined period of time as determined by said time delay switch thereby maintaining a more combustible mixture in the cylinder at a level to reduce the amount of hydrocarbons and carbon monoxide gases exhausted from the cylinder.

7. In the exhaust emission control system according to claim 6 further including a resistor electrically connected in parallel with said first mentioned thermal responsive switch reducing the power supplied to the heater member when said first switch is open and said thermal responsive time delay switch is closed.

8. In the exhaust emission control system according to claim 6 wherein said electrothermal control device comprises:

a housing member having a pair of spaced apart broadsides wherein one of said broadsides is open forming a receiving means, said housing member having a plurality of spaced apart tab members positioned around the periphery of said opening;

an electrically non-conductive base member having a pair of spaced broadsides substantially the size of said opening of said housing member, said base member supporting on one broadside thereof said thermal responsive switch and said thermal responsive time delay switch and on the other broadside having a pair of terminals electrically connected respectively to the actuating arm of each of said switches; and

gasket means extending around the periphery of said one broadside of said base member and cooperating with said tab members to seal said switch members within said housing member thereby preventing corrosive particles from engaging with said switches.

9. In the exhaust emission control system of claim 8 wherein said thermal responsive time delay switch comprises:

an electrically responsive heater element electrically connected at one end thereof in series with said first mentioned switch and at the other end to a source of power; and

a pair of switch members, the actuating arm being a bimetallic member responsive to heat generated by said heater element for a period of time for actuation to an electrically opened switch position.

10. In the exhaust emission control system of claim 8 wherein said first mentioned thermal responsive switch comprises:

a pair of switch members, the actuating arm being a bimetallic member responsive to temperature exceeding 68°F. for actuation to an electrically closed switch position.

11. In the exhaust emission control system according to claim 8 wherein said base member is a rigid nonporous, non-deformable member of glass-filled alkyd material wherein said broadsides are substantially parallel.

12. In the exhaust emission control system according to claim 8 wherein said housing member is an electrically conductive member having means for mounting said member to said engine thereby maintaining said housing at the electrical potential of said engine.

13. In the exhaust emission control system according to claim 12 wherein one of said tabs on said housing is electrically connected to the other end of said heater element.

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